

## Claims

1. A pod door opener comprising:
  - a door opening mechanism;
  - a bulkhead having a seal plane and defining an aperture through which a door of a pod passes when removed by the door opening mechanism; and
  - a work volume for the door opening mechanism, wherein the volume has a height, width, and depth, and the depth does not exceed 80 mm from the seal plane.
2. The pod door opener of claim 1, wherein the width does not exceed 400 mm, generally horizontally centered on the seal plane.
3. The pod door opener of claim 1, wherein the height does not exceed 439 mm, generally vertically centered on the seal plane.
4. The pod door opener of claim 1, wherein the pod door opener is configured to mount to a semiconductor wafer processing tool that permits a work volume for the door opening mechanism to have a depth of up to about 100 mm.
5. The pod door opener of claim 1, wherein the pod door opener is configured to mount to a semiconductor wafer processing tool that permits a work volume for the door opening mechanism to have a width of up to about 414 mm.
6. The pod door opener of claim 1, wherein the door opening mechanism moves the pod door in a horizontal direction and a vertical direction.
7. The pod door opener of claim 6, wherein the door opening mechanism comprises a door retraction device.
8. The pod door opener of claim 7, wherein the door retraction device comprises a bi-directional propulsion device selected from the group consisting of an electromechanical system, an hydraulic system, and a pneumatic system.
9. The pod door opener of claim 6, wherein the door opening mechanism further comprises a vertical positioning system, the vertical positioning system comprising:
  - a lead screw;
  - a conformal rolling nut; and
  - an actuator.

10. The pod door opener of claim 6, wherein the door opening mechanism further comprises a vertical positioning system selected from the group consisting of a guided telescopic lift device, a linear electric motor, a cam driven system, an hydraulic actuator, a pneumatic actuator, a cable drive system, and a magnetically coupled device.

11. The pod door opener of claim 1, further comprising a pinch avoidance system comprising:

- a frame coupled to the bulkhead; and
- at least one switch disposed between the frame and the bulkhead.

12. The pod door opener of claim 1, further comprising a door key latch mechanism for grasping the pod door, the door key latch mechanism comprising:

- a door interface plate coupled to the pod door opener;
- at least one door key latch coupled to the interface plate;
- a bi-directional propulsion device coupled to the interface plate; and
- a yoke coupled between the door key latch and the bi-directional propulsion device for translating a linear motion from the bi-directional propulsion device to a rotary motion on the door key latch.

13. The pod door opener of claim 12, wherein the bi-directional propulsion device is selected from the group consisting of an electromechanical system, an hydraulic system, and a pneumatic system.

14. The pod door opener of claim 1, wherein the bulkhead comprises a monocoque construction.

15. The pod door opener of claim 1, further comprising a sensor for sensing placement and position of the pod.

16. A kinematic tool interface system for use with a pod door opener, the kinematic tool interface system comprising:

- a lower interface including a kinematic shelf and at least one support bracket, wherein the kinematic shelf and the at least one support bracket can be coupled rigidly to a wafer-processing tool;

- at least one kinematic pin disposed on the kinematic shelf, wherein the at least one kinematic pin is independently adjustable and has a range sufficient to perform pitch, roll, and

yaw adjustments to the pod door opener; and

a seismic anchoring device disposed through an underside of the kinematic shelf.

17. The kinematic tool interface system of claim 16 further comprising at least one upper interface for securing the pod door opener to the wafer-processing tool.

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